Vector ecology and implications on epidemiology of citrus variegated chlorosis

João S. Lopes
Dept. Entomology, Plant Pathology and Agricultural Zoology
ESALQ/University of São Paulo, Brazil

Diseases caused by *Xylella fastidiosa* in Brazil

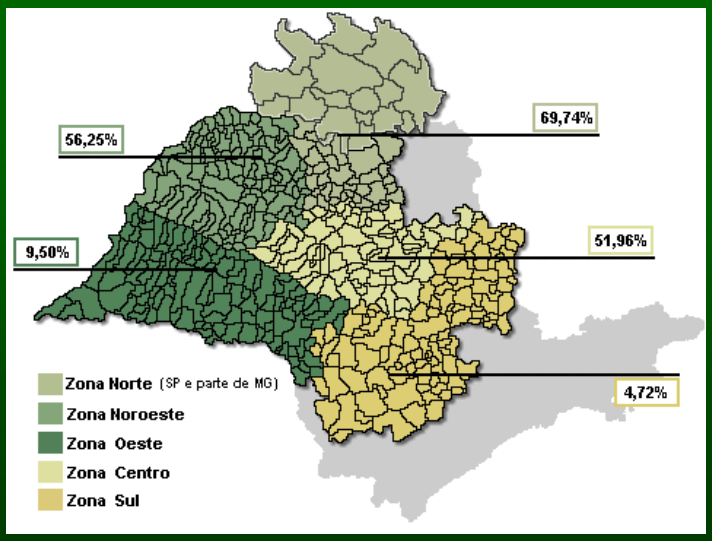
- Citrus variegated chlorosis (CVC)
- Coffee leaf scorch (CLS)
- Plum leaf scald (PLS)

Citrus Variegated Chlorosis

Citrus variegated chlorosis (CVC) in Brazil

- First report: Colina (SP) and Southwest of Minas Gerais - 1987
- Today: all citrus regions in Brazil (including Argentina and Paraguai)

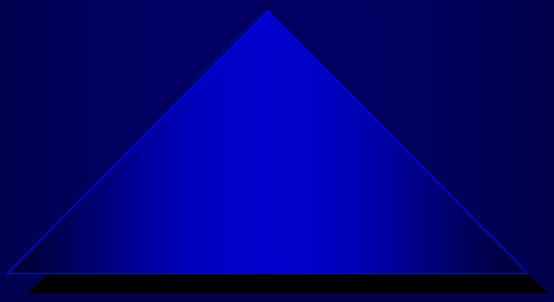
Incidence of CVC in various regions of São Paulo State - 2005



www.fundecitrus.com.br

CVC management

Healthy nursery trees



Pruning
Roguing

Vector control

Vector control with insecticides

Trunk/soil applications

Rainy season

Systemic action

imidacloprid
thiamethoxan (soil)
aldicarb (soil)

Sprays

Dry season

acephate
fenpropathrin
deltametrin
dimetoate
carbaril

Source: Fundecitrus e Gravena

Problems with vector control

- High cost
- Environmental impact
- Long-term susceptibility of citrus to CVC
- Sources of vectors outside citrus groves

How to improve CVC management?

- Inoculum reduction
- Ecological information on key vectors, inoculum sources, critical infection periods
- Alternative vector control methods

.

Vector diversity

Genera of xylem-feeding Auchenorrhyncha in citrus and coffee groves

Cicadellini	Proconiini	Cercopidae
Bucephalogonia	*Acrogonia*	*Deois*
Carneocephala	*Dechacona*	*Neosphenorhina*
Ciminius	*Egidemia*	*Mahanarva*
Diedrocephala	*Homalodisca*	*Zulia*
Dilobopterus	*Molomea*	
Erytrogonia	*Oncometopia*	
Ferrariana	*Pseudometopia*	
Hortensia	*Teletusa*	
Macugonalia	*Tapajosa*	
Oragua		
Parathona		
Plesiommata		
Scopogonalia		
Sibovia		
Sonesimia		
Syncharina		

Yamamoto & Gravena (2000); Giustolin et al.

11 known vector species in Citrus - SP

(Lopes et al. 1996, Krugner et al. 2000, Yamamoto et al. 2002)

Occurrance patterns in citrus groves

- Citrus canopy: Oncometopia, Acrogonia, Dilobopterus, Homalodisca
- Weeds and canopy: Bucephalogonia, Macugonalia
- Grass-feeders: Plesiommata, Ferrariana, Sonesimia, Hortensia

Sharpshooters are abundant on natural habits and host plants surrounding citrus and coffee groves

Host plants in natural habitats

Sharpshooter	Host plant: Nº species	Host plant: No. families
Acrogonia citrina	13	10
Bucephalogonia xanthophis	17	8
Dilobopterus costalimai	15	12
Oncometopia facialis	21	13
Total	40	20

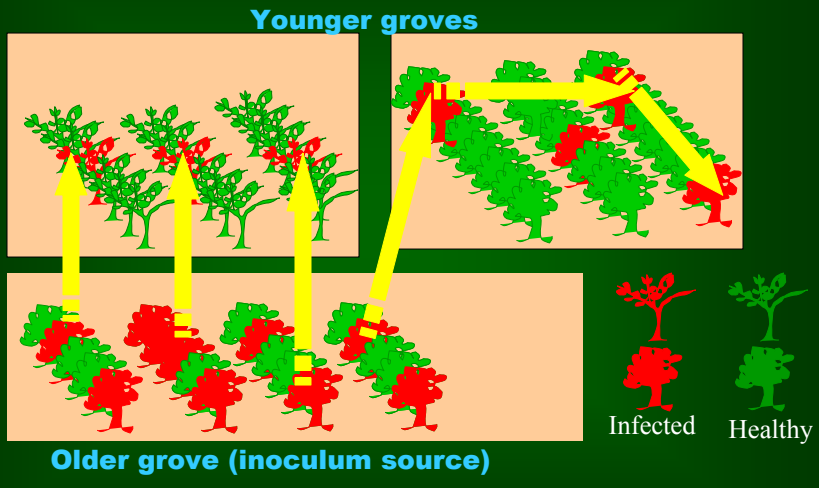
* No. habitats surveyed: 6
** No. plant species surveyed: 107

(Giustolin et al.)

Polyphagous vectors:
Opportunity to carry *X. fastidiosa* among different host plants and habitats

Inoculum sources?

CVC epidemiology: secondary spread is important

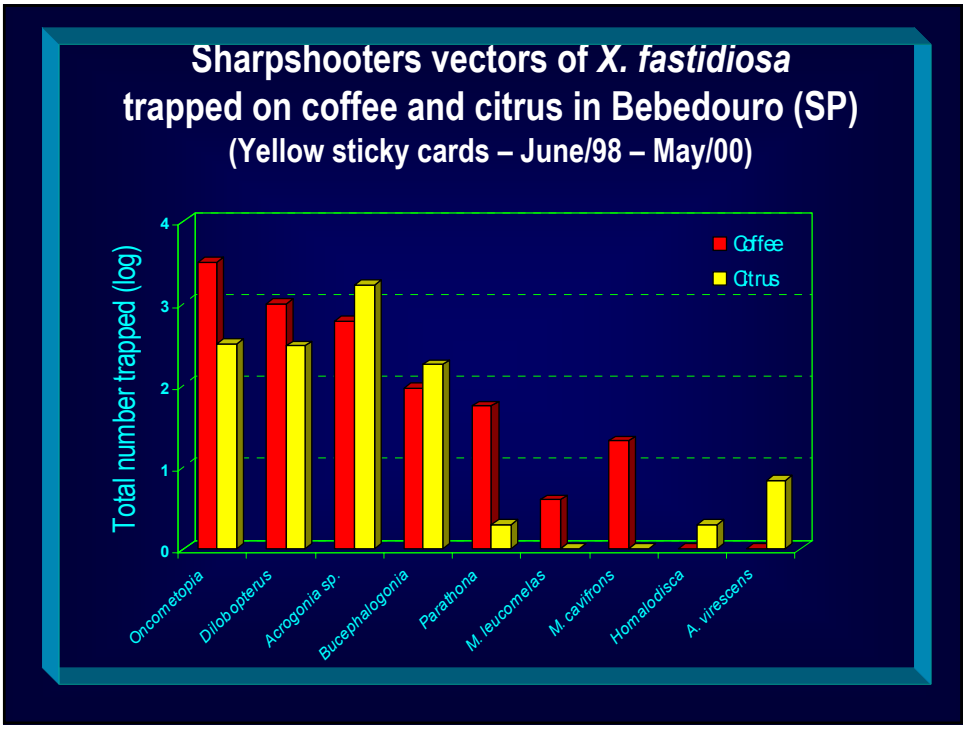


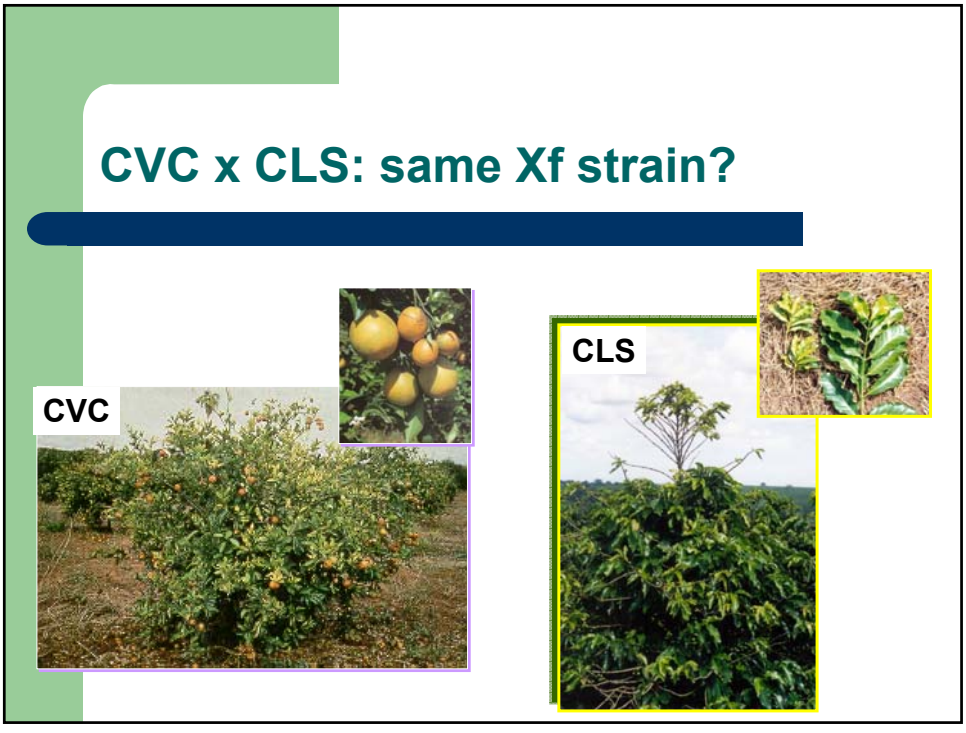
Laranjeira et al. (1998)

Are there *X. fastidiosa* hosts among natural hosts of citrus sharpshooters ?

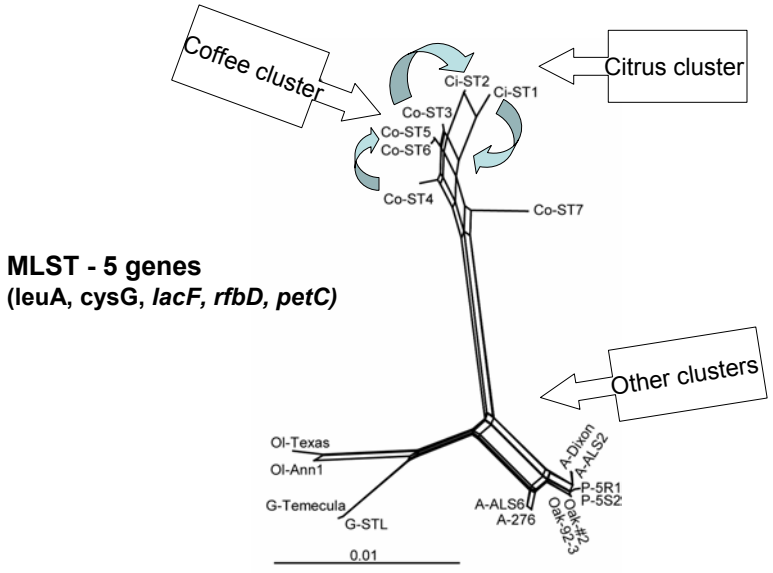
Host plant	Mechanical inoculation of *X. fastidiosa*	
	Symptoms	Culture
Aloysia virgata	0/20	0/20
Baccharis sp.	ND	ND
Cedrela odorata	0/20	0/20
Croton floribundus	0/20	0/20
Gallesia integrifolia	0/14	1/14 +
Gochnatia polymorpha	0/7	2/7 +
Ilex teezans	ND	ND
Lantana camara	ND	ND
Luehea paniculata	0/20	4/20 +
Pterocaulon lanatum	0/20	0/20
Styrax ferrugineus	ND	ND
Vernonia sp1.	0/18	0/18
Vernonia sp2.	0/20	0/20

Citrus and coffee groves
São Paulo, Brazil


Sharpshooters vectors of X. fastidiosa
trapped on coffee and citrus in Bebedouro (SP)
(Yellow sticky cards – June/98 – May/00)
Total number trapped (log)
0
1
2
3
4
Coffee
Citrus
Oncometopia
Dilobopterus
Acrogonia sp.
Bucephalogonia
Parathona
M. leucomelas
M. cavifrons
Homalodisca
A. virescens


CVC x CLS: same Xf strain?
CVC
CLS

Concatenate gene phylogeny of Xf sequence types (STs)



MLST - 5 genes
(leuA, cysG, *lacF, rfbD, petC)*

Almeida et al. (submitted)

Biology – reciprocal inoculations

- Coffee isolates representing different STs do not colonize citrus.

- Some citrus isolates can colonize coffee for a short period (2-4 months), but are no longer detected after 1 year.

Almeida et al. (submitted), Prado et al. (in press)

Can weeds serve as inoculum sources?

- Xf has been detected in some weeds in citrus orchards (Lopes et al. 2003)
- But rapid weed growth and frequent mowing may prevent Xf from reaching high population levels in these hosts.
- Some sharpshooters are abundant on weeds, but rare on citrus (Yamamto & Gravena 2000).

Ferrariana trivittata

Key vectors in Northern S. Paulo State (common species on citrus trees)

Acrogonia citrina

Dilobopterus costalimai

Oncometopia facialis

Bucephalogonia xanthophis

Some species are restricted to citrus groves adjacent to woods

Transmission efficiency

Macugonalia leucomelas	17.3%
Bucephalogonia xanthophis	5.0-12.8%
Dilobopterus costalimais	5.5-13.3%
Plesiommata corniculata	2.9%
Parathona gratiosa	2.8%
Acrogonia citrina	2.3%
Ferrariana trivittata	1.9%
Oncometopia facialis	1.1-1.3%
Sonesimia grossa	1.2%
Homalodisca ignorata	0.5-30%
A. virescens	0.3%

(Krugner et al. 2000; Yamamoto et al. 2002, Marucci et al.)

Critical infection periods?

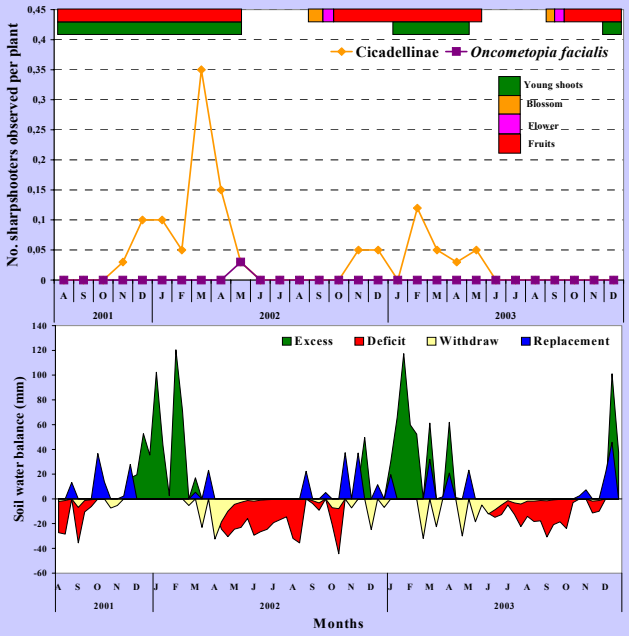
Visual observations
show prevalence of sharpshooters on young shoots during the rainy season

Visual osbservations of sharpshooters on citrus trees - Bebedouro, SP

Citrus phenology

Vector population

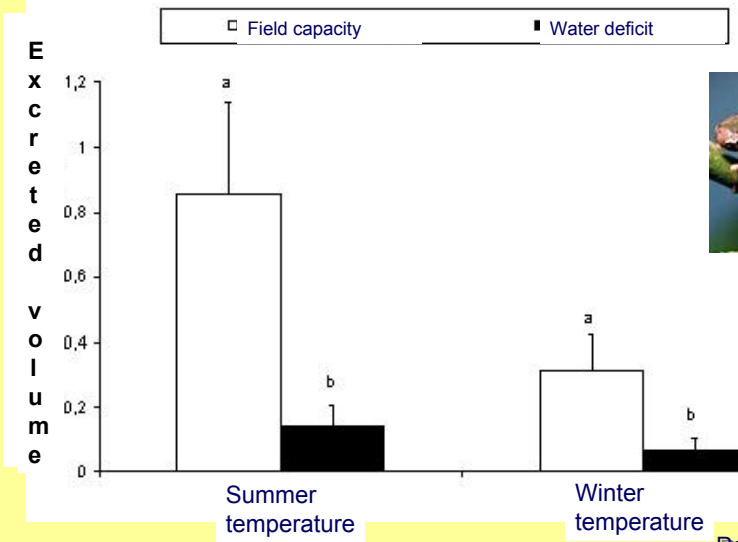
Soil water balance



Giustolin et al.

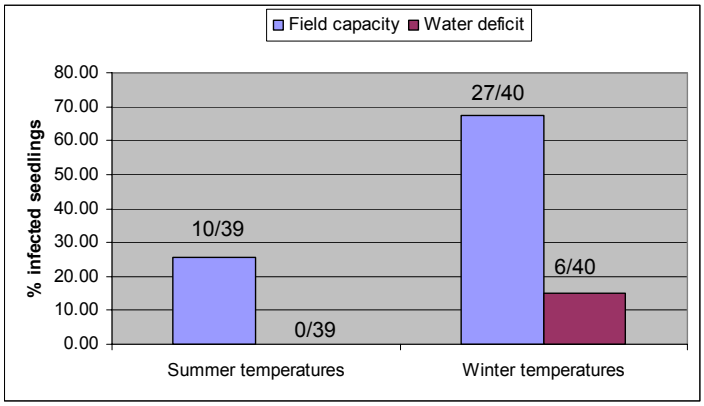
Laboratory study

Sharpshooter feeding x soil water deficit



Pereira et al. 2005

Water deficit also affects Xf infection in citrus seedlings
(bacterial detection at 3 months after mechanical inoculation)



Pereira (2001)

Trap plants
(Vector infectivity + activity)

Frequency of infected trap plants per season

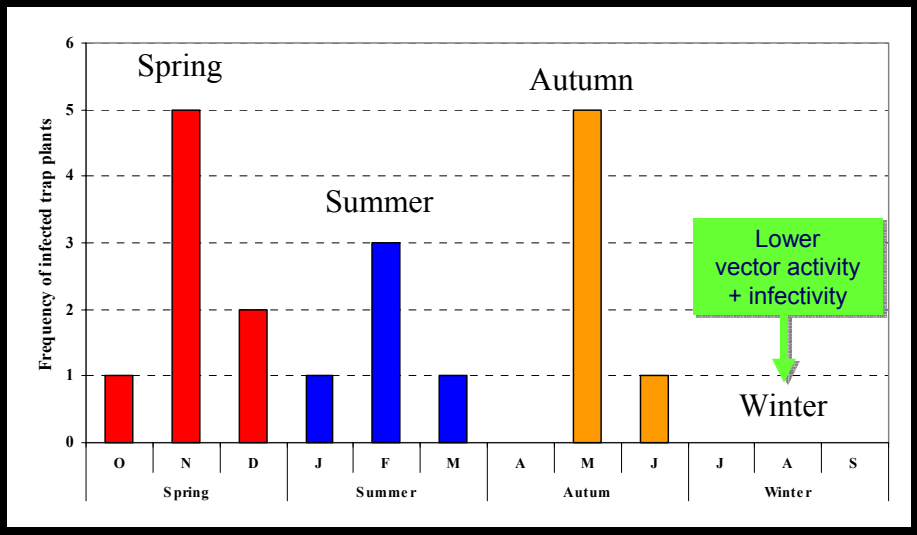
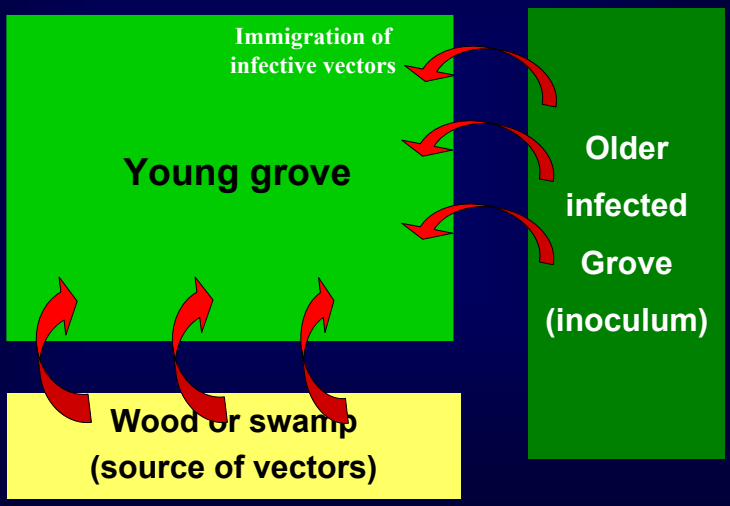


Figure 7. Frequency of naturally infected trap plants per month and season, by pooling data of the three years of sampling in the three citrus groves of Neves Paulista, Gavião Peixoto and Sta. Rita do Passa Quatro (Pooled data of sampling from January/99-December/2001).

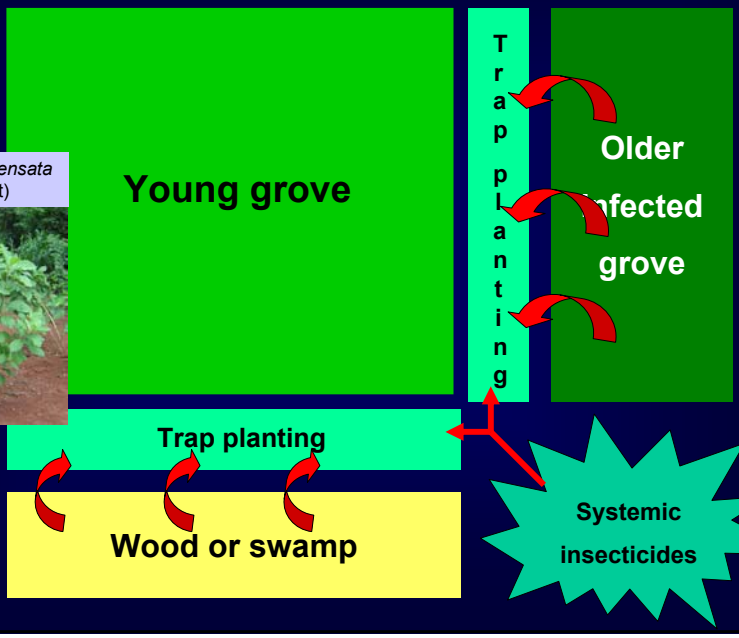
Vector incidence, feeding and bacterial infection are favored during the raining season (spring, summer and fall)

Situations of higher risk of CVC spread

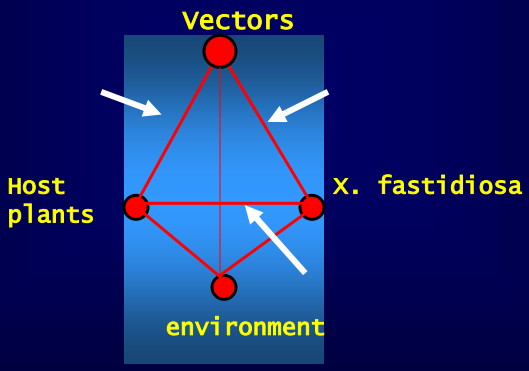
- high inoculum pressure
- sources of vectors



Can trap plants reduce immigration of infective vectors?



Multiple control methods
Interfering in interactions between disease components



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